Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
	)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band	)	RM-11664
	)	
	)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services	)	WT Docket No. 10-112
	)	
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations	)	IB Docket No. 97-95

COMMENTS OF CISCO SYSTEMS, INC.

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January 28, 2016

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EXECUTIVE SUMMARY

Cisco Systems, Inc. ("Cisco") applauds the issuance of the *Notice of Proposed Rulemaking* ("*NPRM*") and the Commission's commitment to maximizing the potential of spectrum in the millimeter wave ("mmW") bands. Certainly, the expected demand for 5G services warrants the adoption of new rules sooner than later. Indeed, adoption and timely implementation of spectrum policy had much to do with establishing the United States as the global leader in 4G communications. Prompt action on the *NPRM* will help position the U.S. to repeat that success in 5G.

Cisco supports the Commission's proposal to create the Upper Microwave Flexible Use Service ("UMFUS") and give 28 GHz and 39 GHz licensees the freedom to deploy any fixed or mobile service over their spectrum. Further, Cisco agrees that mobile use of the 28 GHz band will not upset the legitimate expectations of satellite operators in that spectrum, since they have been secondary to LMDS for two decades. Cisco believes that the secondary market may prove to be a particularly efficient means of providing FSS operators with greater access to the 28 GHz band, without undermining terrestrial mobile services there. Cisco also agrees that terrestrial mobile services can co-exist with federal satellite use of the 39 GHz band, and, under certain conditions, does not oppose the idea of affording satellite operators opportunistic use of the 39 GHz band for downlinks to user terminals.

The Commission should proceed cautiously when considering rules that would permit terrestrial fixed and mobile use of the 37 GHz band. Among other things, potential enterprise or industrial users have not yet organized or amassed sufficient interest in the mmW bands to initiate the necessary technological development. Cisco therefore looks forward to exploring the relevant issues with interested parties, including evaluation of other bands where enterprises could be afforded priority rights to spectrum.

As a general principle, the Commission should use a "light touch" when crafting rules for mobile use at 28 GHz and 39 GHz. Cisco believes it is premature and unnecessary for the Commission to consider whether the spectrum access system ("SAS") for the 3.5 GHz band would be appropriate for the 28 GHz band. Until the merits of the 3.5 GHz SAS are fully vetted, the Commission should retain its ban on FSS fixed user stations and require that licensees share information about their systems, without mandating any particular type of sharing mechanism. Cisco further requests that the Commission facilitate the use of either Time Division Duplex or Frequency Division Duplex by making the mmW spectrum available in unpaired blocks.

More broadly, the Commission's regulatory framework should require that new mmW technologies reasonably co-exist with technologies already brought to market. The Commission should further make clear that the onus to reach accommodation should be on market participants, and that the Commission would not expect to referee a debate on the matter nor delay the introduction of new technology.

In accordance with the "light touch" approach recommended herein, the Commission should adopt an open eligibility standard for UMFUS licensees, and continue to permit 28 GHz and 39 GHz licensees to lease, partition and disaggregate their spectrum regardless of the

services being provided. As to geographic licensing, Cisco recommends that the Commission retain the use of Basic Trading Areas for 28 GHz and Economic Areas for 39 GHz. Lastly, the Commission's performance benchmarks for UMFUS licensees must account for the shorter range and quasi-optic character of the mmW bands (as opposed to the lower frequencies used for wide-area service, where population-based benchmarks are more appropriate). Cisco believes, for example, that performance metrics based on number of connected devices, carried traffic and/or session count would paint a more accurate picture of spectrum utilization in the mmW bands. Cisco encourages the Commission to consider adopting one or more of these innovative approaches.

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COMMENTS OF CISCO SYSTEMS, INC.

Cisco Systems, Inc. ("Cisco") hereby submits its initial comments in response to the Commission's *Notice of Proposed Rulemaking* in the above-captioned proceedings.[1]

[1] Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *Notice of Proposed Rulemaking*, 30 FCC Rcd 11878 (2015) ("*NPRM*").

I. INTRODUCTION.

Cisco, based in San Jose, California, is a leading vendor to U.S. mobile operators, and to mobile operators throughout the world. Our solutions allow mobile operators greater control, flexibility, and agility in running their networks, including greater ease in offering new services, particularly as networks and service offerings become virtualized. These solutions, incorporating pervasive security, work with other Cisco offerings, such as Unified RAN backhaul, Universal Wi-Fi, Universal Small Cell and the award-winning Mobility IQ, the industry's first and most complete cloud service that unifies and harnesses visual network knowledge. In addition, Cisco annually publishes our "Mobile Visual Networking Index" ("Mobile VNI") reporting on data demand trends in the U.S. and around the world. The Mobile VNI is widely used by regulators, policy makers and operators in decision-making.

II. EXPEDITED ACTION IN THIS PROCEEDING WILL DRIVE INNOVATION AND NEW SERVICES IN THE MILLIMETER WAVE BAND.

Cisco applauds the issuance of the *NPRM* and the Commission's commitment to maximizing the potential of spectrum in the millimeter wave ("mmW") bands above 24 GHz. The Commission's leadership has the potential to advance the development and timely deployment of Fifth Generation ("5G") mobile wireless services and other new offerings to consumers. For the reasons set forth herein, Cisco urges the Commission to maintain its forward thinking approach and take expedited action on the proposals in the *NPRM*, ideally with the objective of having rules in place before fall of 2016.

Certainly, the expected demand for 5G services warrants the adoption of new rules sooner than later. Mobile data traffic is increasing exponentially, and additional spectrum

allocations are essential to meet that growing demand, particularly in the most congested areas. For example, Cisco estimates that by 2019:[2]

- Global mobile data traffic will reach 24.3 exabytes per month, a nearly tenfold increase from 2014.
- The average mobile network connection speed will reach nearly 4.0 Mbps (compared to 1.7 Mbps in 2014).
- Nearly three-fourths of the world's mobile data traffic will be video, and mobile-connected tablets will generate nearly double the traffic generated by the entire global mobile network in 2014.
- The average smartphone will generate 4.0 GB of traffic per month, versus 819 MB per month in 2014.

Similar statistics and other information referenced in the *NPRM* likewise confirm that expedited Commission action in this proceeding would serve the public interest.[3]

Cisco agrees that "[w]aiting to develop a regulatory framework [for the mmW bands] would have several disadvantages," including, among other things, a risk that delayed action may compromise the United States' leadership in mobile communications.[4] Adoption of spectrum policy and the timely implementation thereof plays an influential role in technological innovation, and has had much to do with establishing the United States as the global leader in 4G communications. Indeed, global technology companies by and large innovated in this country because the U.S. was well ahead of the rest of the world in 4G deployment.[5] Prompt action on the *NPRM* will help position the U.S. to repeat that success in 5G.

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[2] *See* Cisco, Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014 – 2019 White Paper (Feb. 2015), http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html.

[3] *NPRM*, 30 FCC Rcd at 11883 ¶ 8.

[4] *Id.* at 11889 ¶ 24.

[5] By way of example, the digital TV transition and consequent availability of the 700 MHz band facilitated domestic deployment of advanced wireless network ahead of the rest of the world.

Further, as pointed out in the *NPRM*, the 27.5-29.5 GHz, 37-40.5 GHz and the 59.3-76 GHz bands, among others, are potential global mobile allocations.[6] While it is disappointing that WRC-2015 did not accept proposals by the United States, among others, to consider at WRC-2019 the identification for International Mobile Telecommunications of the 27.5-28.35 GHz ("28 GHz") band, Chairman Wheeler and Commissioner Rosenworcel have correctly noted that the United States should not be deterred in its efforts to promote the 28 GHz band for mobile use, as the rest of the world will likely see the benefits of the 28 GHz band once the United States moves forward.[7] For technology companies to make the substantial investments necessary for developing 5G equipment, the Commission must (1) provide reasonable assurance that the market for mmW-based mobile services will be large enough to justify those investments, and (2) provide technology companies with certainty as to what technical rules will apply to those services. Near-term resolution of the *NPRM* would be a substantial step towards achieving both results and freeing industry to satisfy the expanding demand for mobile data.

III. THE COMMISSION SHOULD ADOPT ITS PROPOSED FLEXIBLE USE FRAMEWORK FOR THE 28 GHZ AND 39 GHZ BANDS.

A. THE UPPER MICROWAVE FLEXIBLE USE SERVICE

Cisco supports the Commission's proposal to create the Upper Microwave Flexible Use Service ("UMFUS") and give 28 GHz and 38.6-40.0 GHz ("39 GHz") licensees in that service

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See also id. at 11884 ¶ 12 ("Since the release of the Commission's *NOI* in October 2014, there has been increased momentum behind the development of 5G technologies.").

[6] *Id.* at 11885 ¶ 13.

[7] FCC, Statement of Tom Wheeler, Chairman, Presentation on the outcomes of the International Telecommunication Union's World Radio Conference that took place in November 2015 (rel. Dec. 17, 2015); FCC, Statement of Jessica Rosenworcel, Commissioner, International Bureau Presentation on World Radiocommunication Conference 2015 (WRC-15) (rel. Dec. 17, 2015).

the freedom to deploy any fixed or mobile service in that spectrum.[8] The benefits of this approach are manifest in other spectrum, since it "allows licensees to pursue any technology most expedient for achieving their operational goals in responding to marketplace pressures and consumer demand."[9] That same opportunity can and should be made available in the 28 GHz and 39 GHz bands.

Cisco also supports the Commission's proposal to afford flexible use rights to incumbent licensees, and to auction vacant 28 GHz and 39 GHz spectrum in accordance with Section 309(j) of the Communications Act, as amended.[10] The success of auctions in directing spectrum towards its highest and best use is a matter of record, and a properly constructed auction will achieve equally beneficial results here.[11]

B. CO-EXISTENCE WITH SATELLITE SERVICES

Cisco agrees that mobile use of the 28 GHz band will not upset the legitimate expectations of satellite operators in that spectrum. Fixed-Satellite Service ("FSS") incumbents have been secondary to Local Multipoint Distribution Service ("LMDS") licensees for two decades,[12] and FSS earth station licensees "constructed their facilities knowing that their

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[8] *See NPRM*, 30 FCC Rcd at 11891-92 ¶ 30, 11895 ¶ 42, 11931 ¶ 182.

[9] Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, *Second Order on Reconsideration*, 30 FCC Rcd 6746, 6756 ¶ 20 (2015) (citation omitted).

[10] *NPRM*, 30 FCC Rcd at 11947 ¶¶ 244-245.

[11] Cisco does not, however, favor the Commission's proposal to establish an auctionable overlay right that would allow new licensees flexible use subject to noninterference by the incumbent licensees. *Id.* at 11909 ¶ 97. Auctioning of overlay rights would add unnecessarily complexity to the Commission's UMFUS auction, while running the risk of discouraging participation by bidders who otherwise are ready, willing and able to deploy new services in the 28 GHz and 39 GHz bands.

[12] 47 C.F.R. § 25.202. *See also NPRM*, 30 FCC Rcd at 11891 ¶ 27.

operations would be on a secondary basis."[13] Thus, FSS incumbents cannot claim that their interference protection rights will be compromised if LMDS operators are afforded flexible use of their spectrum. Mobile services elsewhere in the world already have co-primary status at 28 GHz, so FSS operators also should not be surprised that the Commission seeks to give 28 GHz mobile service primary status here.

Cisco also agrees that satellite use of the 28 GHz band will not be precluded by mobile use of that spectrum. The *NPRM* does not propose to preclude continued operation of FSS earth stations on the same secondary basis that is permitted today. Moreover, "to prevent incursions by terrestrial operators that might otherwise require them to shut down their FSS gateways," the Commission has proposed to permit FSS operators to acquire UMFUS licenses via the secondary market or at auction and thereby effectively secure co-primary status.[14] Since FSS uplinks at 28 GHz are relatively few in number and are located mostly in rural areas, Cisco believes that the secondary market may prove to be a particularly efficient means of providing FSS operators with greater access to the 28 GHz band, without undermining terrestrial mobile services there.[15]

Lastly, Cisco agrees with the Commission that terrestrial mobile services can co-exist with federal satellite use of the 39 GHz band.[16] While coordination will have to be done by the Commission staff and their counterparts at the National Telecommunications & Information Administration, co-existence is achievable. Cisco also does not oppose the idea of affording satellite operators opportunistic use of the 39 GHz band for downlinks to user terminals, provided that there is no interference to terrestrial UMFUS use and that user terminals are

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[13] *NPRM*, 30 FCC Rcd at 11920 ¶ 137.

[14] *Id.* at 11918-19 ¶¶ 132-134.

[15] *See id.* at 11907-08 ¶ 93, 11921 ¶ 143.

[16] *See id.* at 11927-29 ¶¶ 166-172.

sufficiently frequency agile that services can be migrated to other spectrum as providers of 39 GHz terrestrial mobile services expand their operations and require in their licensed areas the cessation of satellite services.

IV. IDENTIFYING APPROPRIATE RULES FOR TERRESTRIAL USE THE 37 GHZ BAND REQUIRES FURTHER DEVELOPMENT OF THE RECORD.

Cisco endorses the Commission's view that the 37.0-38.6 GHz ("37 GHz) band "could potentially support high data-rate transmissions," and that it therefore is appropriate to consider adoption of rules that would allow terrestrial fixed and mobile use of that spectrum.[17] The *NPRM*'s proposal for the establishment of a "hybrid" licensing approach in the band – one in which property occupants would have, by rule, the exclusive right to utilize the 37 GHz band within their facility boundaries, while rights to outdoor operations would be assigned by geographic area – is intriguing.[18] Cisco cautions, however, that the Commission must consider some critical issues before proceeding too far down that path.

Leaving aside the question of whether the 37 GHz band is an appropriate home for such networks, Cisco believes that there is a marketplace need for privately deployed networks that support advanced enterprise applications. Particularly in the wake of recent Commission decisions on Wi-Fi "blocking" in commercial environments,[19] there is a clear tension between using bands established for Part 15 use in enterprise or industrial settings where the use case requires active management of spectrum. Those challenges will be compounded as the Internet

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[17] *Id.* at 11897 ¶ 51.

[18] *Id.* at 11881 ¶ 3.

[19] *See* Marriott Int'l, Inc.; Marriott Hotel Servs., Inc., *Order and Consent Decree*, 29 FCC Rcd 11760 (EB 2014); Smart City Holdings, LLC et al., *Order and Consent Decree*, 30 FCC Rcd 8382 (EB 2015); M.C. Dean, Inc., *Notice of Apparent Liability*, 2015 FCC Lexis 3280 (rel. Nov. 2, 2015); Hilton Worldwide Holdings, Inc., *Notice of Apparent Liability*, 2015 FCC Lexis 3269 (rel. Nov. 2, 2015).

of Things continues to grow and the demand for wireless connectivity proliferates, since at least some of that connectivity will require the sort of enterprise control that Part 15 may no longer support.

Conceptually, Cisco believes that enterprise control would most likely be utilized for indoor use cases for the most part, and probably at power levels below what is necessary for wide area services. The difficulty, however, is that potential enterprise or industrial users have not yet organized or amassed sufficient interest in the mmW bands to initiate the necessary technological development. As a result, important issues, such as the interference modeling discussed in paragraph 104 of the *NPRM*, are not easily explored at this time. Similarly, Cisco is unable at this time to offer any substantive proposals as to how the 37 MHz spectrum might be channelized to accommodate indoor enterprise use. Furthermore, a sub-segment of the enterprise user group has advised Cisco that the mmW bands at issue in this docket will not be adequate for various reasons, including high energy demands. Cisco therefore looks forward to reviewing the comments filed on the *NPRM* and to working cooperatively with the Commission and interested parties to resolve these matters, including potentially exploring different bands for a system in which enterprises would have priority rights to spectrum.

V. THE COMMISSION SHOULD USE A LIGHT TOUCH WHEN CRAFTING RULES FOR MOBILE USE IN THE MILLIMETER WAVE BANDS.

It is essential to remember that mobile use of the mmW bands is in its infancy and will require development of new technologies for new business cases. Accordingly, excessively prescriptive rules could easily stall that development and discourage investment. As a general principle, then, the Commission should use a "light touch" when crafting rules for mobile services in the mmW bands.

A. TECHNICAL RULES

1. SPECTRUM ACCESS SYSTEM (SAS)

In the context of allowing FSS use of user terminals in the 28 GHz band, the Commission is considering whether to facilitate terrestrial/satellite sharing through a spectrum access system ("SAS") similar to that required by the recently-adopted rules for the 3.5 GHz band.[20] Cisco submits that this proposal is premature and unnecessary.

The 3.5 GHz SAS remains under development, and whether it will prove a success remains open to debate. The wireless industry and the Commission would be better served by focusing their energies on deploying and evaluating the 3.5 GHz SAS, rather than debating over whether the concept should be applied to other bands. Until the merits of the 3.5 GHz SAS are fully vetted, the Commission should retain its ban on FSS fixed user stations, and simply require that licensees share information about their systems, without mandating that those licensees use any particular type of sharing mechanism (*e.g.*, a database).[21]

2. TDD/FDD

Cisco believes that Time Division Duplex ("TDD") is likely to be the predominant technology for mobile use of the mmW bands. At the same time, the Commission rightly observes that "there is no need to mandate a duplexing option at this stage of mmW technology research and development."[22] Cisco thus supports the Commission's proposal to allow TDD and Frequency Division Duplex deployment in the mmW bands, and further requests that the

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[20] *NPRM*, 30 FCC Rcd at 11923-24 ¶¶ 150-153.

[21] Proposed Section 30.205 of the Commission's Rules mandates the sharing of extraordinarily granular data by terrestrial licensees – data that is likely to be far more burdensome for terrestrial licensees to maintain than the value of that data to FSS licensees. Thus, Cisco urges the Commission to work with industry to reduce the *NPRM*'s proposed data sharing requirements to just the data that is likely to be meaningful to the recipient.

[22] *Id.* at 11955 ¶ 269.

Commission facilitate use of either technology by making the spectrum available in unpaired blocks.

3. Introduction of New Technologies

Consistent with good engineering practice and the need to avoid disruption of mmW services, the Commission's regulatory framework should require that new mmW technologies reasonably co-exist with technologies already brought to market. The Commission should purposefully keep this requirement at a high level so as not to impede the development of new technologies. "Reasonable" co-existence implies that new radio technologies should be expected to access and use radio spectrum in ways that are different from solutions historically available, while respecting that existing technologies serve a useful economic or social function. While licensed ecosystems typically prepare new generations of equipment to reasonably co-exist with older generations, there is not currently a defined or consensus standards platform to ensure that this result can obtain with unlicensed technologies. The Commission should further make clear that the onus should be on market participants to reach accommodation, and that the Commission would not expect to referee a debate on the matter nor delay the introduction of new technology.

Particularly given that technology for the UMFUS bands is in its infancy, interest in the bands will only be spurred if the Commission assures that licensees will have adequate time for the technology to evolve, for standards-setting activities to take place, and for deployment to occur. A ten year license term, as proposed in the *NPRM*,[23] coupled with an expectation of renewal upon meeting performance benchmarks, is the minimum that is likely to encourage investment in the UMFUS bands.

[23] *See id.* at 11915-16 ¶ 122.

In accordance with the "light touch" approach recommended above, Cisco endorses the Commission's proposal to adopt an open eligibility standard for UMFUS licensees, one in which all interested parties, including FSS licensees seeking the functional equivalent of co-primary status for their earth stations, can secure licenses.[24] Given all of the questions that remain as to how the bands will develop, it is premature for the Commission to even consider limiting the participation of any industry segment.

Cisco also agrees that the Commission should continue to permit 28 GHz and 39 GHz licensees to lease, partition and disaggregate their spectrum, regardless of whether they provide fixed service, mobile service or both.[25] The flexibility inherent in these options assures that service providers and other prospective licensees can tailor their authorized service area to their own particular business needs.

Cisco supports geographic area licensing for UMFUS licensees in the 28 GHz and 39 GHz bands, with both fixed and mobile services authorized under a single license.[26] However, Cisco suspects that counties, as proposed in the *NPRM*,[27] are too small a geographic area to promote the most efficient and effective deployment in the band, and urges the Commission to retain the use of Basic Trading Areas for 28 GHz and Economic Areas for 39 GHz. This will ensure consistency with the Commission's use of geographic area licensing in other flexible use spectrum, and, with partitioning, disaggregation and secondary market transactions, will provide the flexibility for UMFUS licensees to tailor their buildouts as necessary to most effectively

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[24] *See id.* at 11933 ¶ 189.

[25] *Id.* at 11944-47 ¶¶ 229-242.

[26] *Id.* at 11907-08 ¶¶ 93-95.

[27] *See id.* at 11912 ¶ 110.

respond to market demand. Larger service areas will also reduce transaction costs and provide licensees with greater certainty as to where they may deploy service without risk of interference.

B. PERFORMANCE REQUIREMENTS

The Commission proposes to require that UMFUS licensees comply with specific performance requirements to ensure timely provision of service, while "strik[ing] an appropriate balance between providing licensees with operational flexibility and ensuring that spectrum does not lie fallow."[28] While Cisco certainly agrees that licensees should be required to meet minimum performance requirements, it is equally important that any benchmarks be sufficiently flexible so as to avoid restricting meritorious UMFUS band business cases, and should not require deployments before mobile technology has had time to evolve.

As to the timing of performance evaluation, because of the nascent state of technology in the mmW bands, it would be inappropriate to measure performance prematurely. The best approach here is to measure performance at the end of the initial license term, which provides industry an ample opportunity to develop technology, set standards, evaluate business cases, and deploy successful businesses without performance requirements forcing it into less than optimal technologies or use cases. It is also important to recognize that small cell deployments presently are far less mature than macrocell deployments, and thus small cell business models are just starting to emerge. It is already clear that the economic risks of deploying in the mmW bands are significant – small cell deployment costs loom large, and return on investment depends on the development of a viable ecosystem of supporting chipsets, devices and infrastructure. Adding the risk of license forfeiture due to premature performance evaluation does not advance the cause of promoting investment and innovation in the UMFUS bands.

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[28] *Id.* at 11935 ¶ 193.

The *NPRM* proposes to require that an UMFUS licensee provide at least some coverage to sufficient number of census blocks that have a total population of those census blocks is equal to 40% of the county's total population.[29] While an interesting take on the Commission's traditional coverage metrics, this proposal nonetheless harkens back to the Commission's performance requirements for lower frequency, mobile wireless systems that provide wide area coverage. Those types of systems provide a relatively narrow range of services and are supported by a mature, well-established economic model. Thus, it is appropriate to evaluate their buildouts using the more conventional metric of residential census data.

The UMFUS bands, however, present a very different story. Propagation at mmW frequencies is inherently shorter range and quasi-optic in character, and thus the UMFUS bands are unlikely to be used for ubiquitous large-area wireless coverage. Many deployments may instead be focused towards small cells, perhaps with less ubiquity due to the stronger shadowing behavior of higher frequency cells deployed in amongst the clutter. Consequently, in comparison to lower band macrocells, UMFUS small cells may be more heavily utilized for capacity augmentation in higher-density locations (*i.e.*, local capacity addition, on top of existing macrocell coverage). Examples may include locations with high levels of commercial activity, *e.g.*, public plazas, public transportation hubs, malls, stadiums, businesses, etc. Furthermore, the emergence of the Internet of Things will push some mmW deployments towards a completely different type of market: machine-to-machine ("M2M") applications that focus on the communication of devices directly with each other and which may take place at locations that are unrelated to the location of the residential population. For example, extensive industrial M2M communications may take place in industrial areas where residential population often is scarce.

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[29] *Id.* at 11939 ¶ 207.

Hence, Cisco believes that performance metrics that account for the availability of supporting devices and infrastructure will paint a more accurate picture of spectrum utilization in mmW networks.[30] This is best achieved by using metrics based on network usage and/or service levels, rather than population or area coverage. The metrics also need to be flexible, so that they accommodate the considerable variety of 5G applications presently being discussed in the relevant standards bodies and industry fora. For instance, the Commission might evaluate a mmW network's performance using metrics such as number of connected devices, carried traffic, and/or session count. Cisco encourages the Commission to consider adopting one or more of these innovative approaches, in cooperation with network providers, equipment manufacturers and other affected parties in this proceeding.

[30] *See id.* at 11939 ¶ 209 (asking for comment on whether there are "other non-population based technical metrics that should be considered in measuring performance (*e.g.*, use of services associated with the link, capacity of the link)").

VI. CONCLUSION.

The Commission is again to be applauded for issuing the *NPRM* and continuing its leadership in identifying possible solutions for meeting the ongoing spectrum crunch. Adoption of the proposals advanced in the *NPRM*, with the modifications proposed above, will go far to maintaining America's global leadership in 5G and assuring that American consumers reap the benefits of 5G technology as soon as it becomes available.

Respectfully submitted,

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January 28, 2016